MITOS P-PUMP FLOW CONTROL

USER INSTRUCTIONS

Contents

1. Introduction

These user instructions describe how to use the Mitos P-Pump (with flow sensor connected in-line) in flow control mode. Flow control mode allows a flow rate to be selected instead of a pressure and the P-Pump pressure is automatically adjusted to achieve the target flow rate. The benefit of flow control mode is that it accounts for changes in the flow resistance of the system to maintain constant flow rate.

To operate in flow control mode, the Mitos Flow Rate Sensor (Part No. 3200096 – 3200100) must be connected to the Mitos P-Pump using either the Mitos Sensor Display (Part No. 3200095) or Mitos Sensor Interface (Part No. 3200200). The table below shows the compatible configurations for newly purchased hardware.

Sensor Interface Type	Mitos P-Pump (3200016)	Mitos P-Pump Basic (3200175)	Mitos P-Pump Remote (3200176)	Mitos P-Pump Remote Basic (3200177)
 **Mitos Sensor Display** (Part No. 3200095)	✓		✓	
 **Mitos Sensor Interface** (Part No. 3200200)	✓	✓	✓	✓

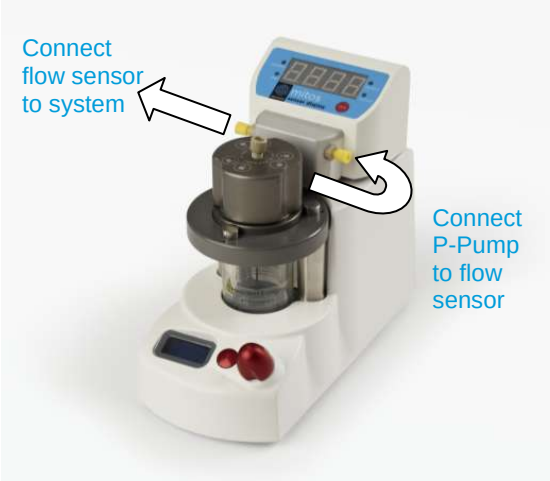
Notes:

For users who already own Dolomite products, the following hardware compatibility applies:

- P-Pumps with serial numbers lower than 160290 are not compatible with any flow sensor interface
- P-Pumps with serial numbers greater than 160290 but lower than 160444 are only compatible with Mitos Sensor display
- P-Pumps with serial numbers greater than 160444 are compatible with any flow sensor interface

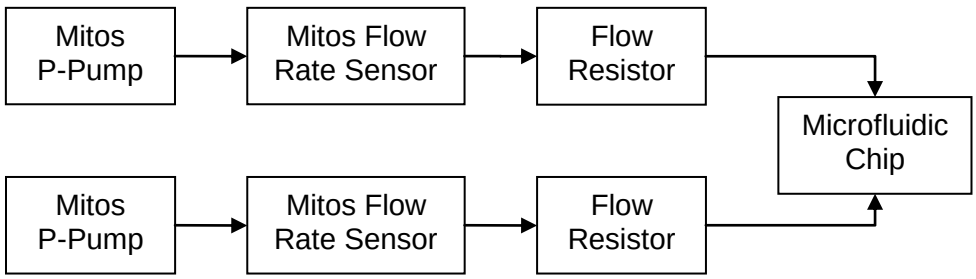
2. Fluidic Connections

The flow rate sensor should be connected between the Mitos P-Pump and the microfluidic system as shown below.



Mitos Flow Rate Sensor connected to a Mitos P-Pump

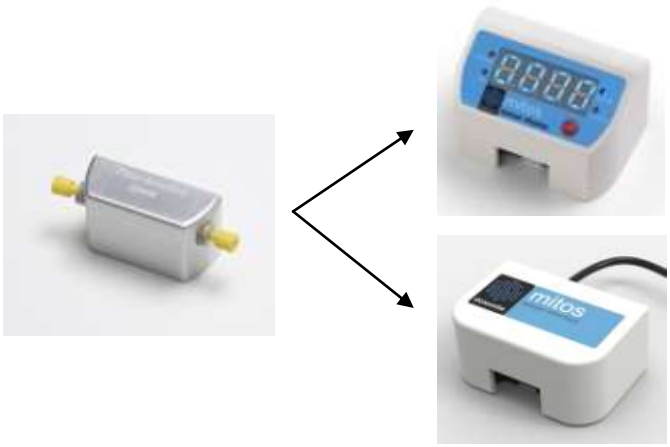
When using the Mitos P-Pump in flow control mode, flow resistors will be required. Flow resistors allow the user to bring a system into the desired flow rate range. In experiments such as droplet generation, where 2 fluids of different viscosity meet at a junction, flow resistors are needed to provide stability.



Use of flow resistors in a flow control system diagram

3. Electrical Connections

To enable flow control, a Mitos Flow Rate Sensor must first be connected to either a Mitos Sensor Display or Mitos Sensor Interface. Then connection must be made to the Mitos P-Pump.



Electrical Connection of Mitos Flow Rate Sensor to Mitos Sensor Display or Mitos Sensor Interface.

Slide Mitos Flow Rate Sensor into position ensuring that the latch has clicked closed

Electrical Connection of Mitos Sensor Display to the Mitos P-Pump

Use USB cable supplied with the Mitos Sensor Display. **Please note that only the top USB port of the Mitos P-Pump can be used for connection of the Mitos Sensor Display.**

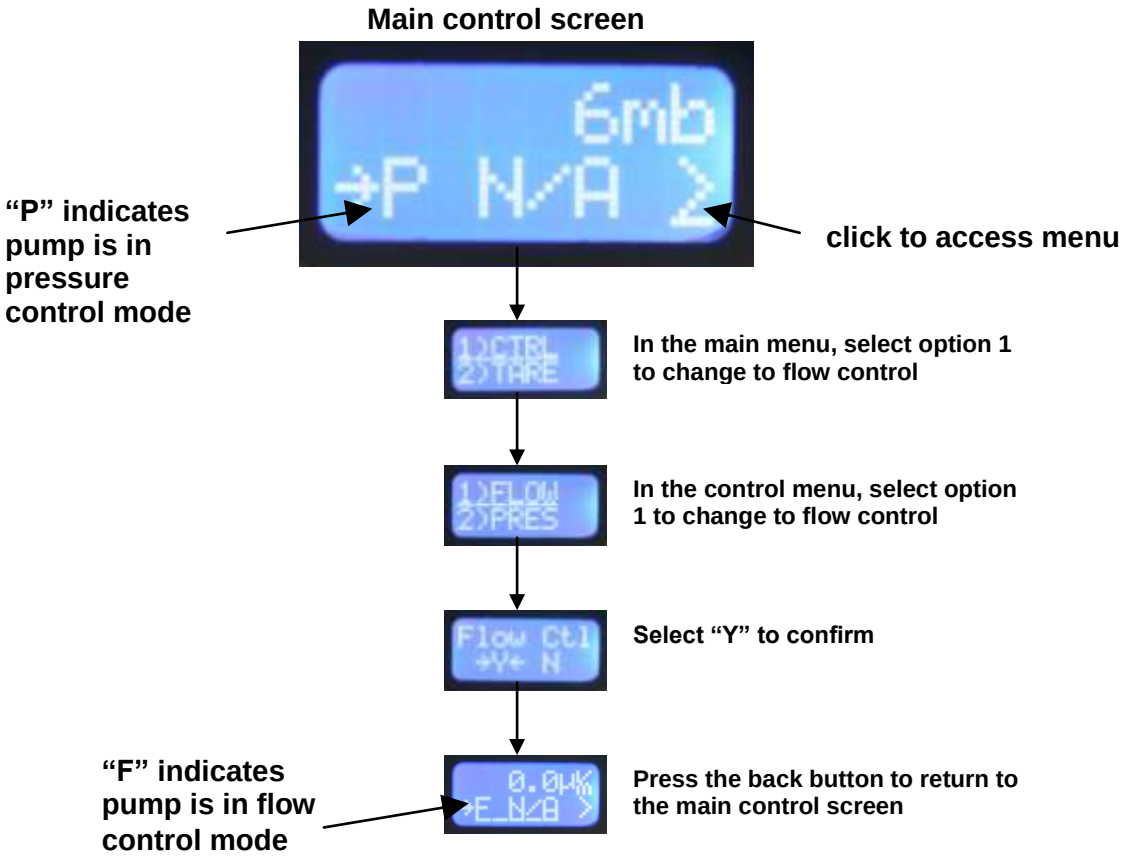
Electrical Connection of Mitos Sensor Interface to the Mitos P-Pump

Use circular multi-pin cable attached to the Mitos Sensor Display to make connection to the Mitos P-Pump

4. Manual User Control

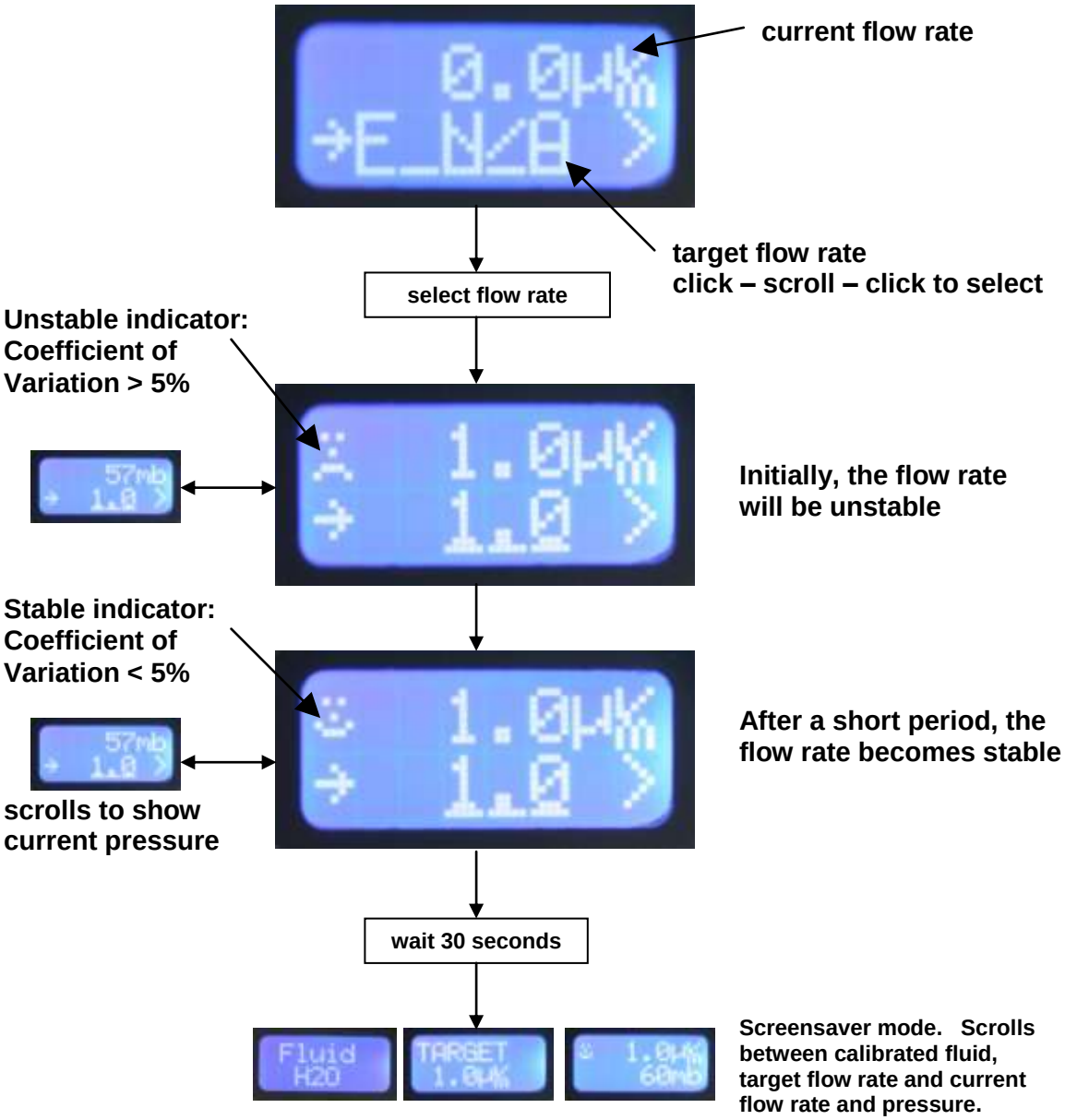
4.1 Changing to Flow Control Mode

The “ctrl” (control) menu option allows the user to switch to flow control mode. **This menu option only appears when a Mitos Flow Rate Sensor is electrically connected to the Mitos P-Pump** (see section 3).



4.2 Setting Target Flow Rate

When in flow control mode, a flow rate can be selected based on the flow rate sensor type connected. The available flow rate range is 20% of the minimum value to the maximum value. For example, the Mitos Flow Rate Sensor 1 – 50 µl/min (Part No. 3200098) has flow rate range of 0.2 – 50 µl/min for the user to select.



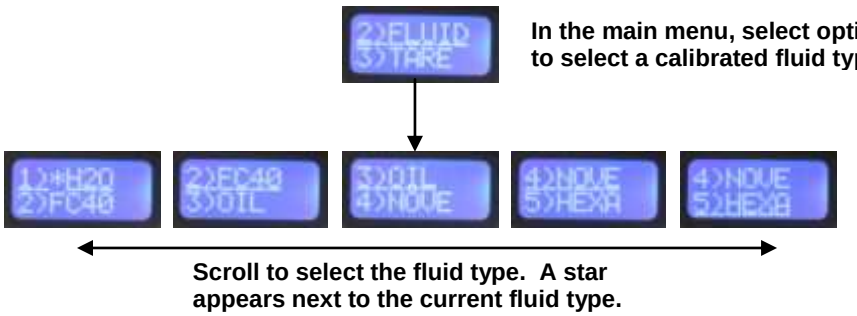
The stability indicator appears next to the flow rate value showing that the pump is in flow control mode. When in pressure control mode, the stability indicator appears next to the pressure value.

4.3 Default Target Values When Changing Control Mode

The user can change between pressure and flow control modes without stopping the flow. When changing from flow control mode to pressure control mode, the default target pressure will be the current pressure when the change is made (60 mb in the example above). Similarly, when changing from pressure control mode to flow control mode, the default target flow rate will be the current flow rate when the change is made. In this way, there is minimal disruption to the flow system when changing control mode. This feature allows the user to set up a system using pressure control and then switch to flow control or vice versa.

4.4 Fluid Calibrations

The Mitos Flow Rate Sensors are calibrated to provide an accurate reading when used with water. The "fluid" menu option allows an alternative fluid type to be selected from a list of 4 common fluids. Selecting an alternative fluid ensures that the flow sensor reading is now accurate for the selected fluid. **This menu option only appears when a Mitos Flow Rate Sensor is electrically connected to the Mitos P-Pump** (see section 3).

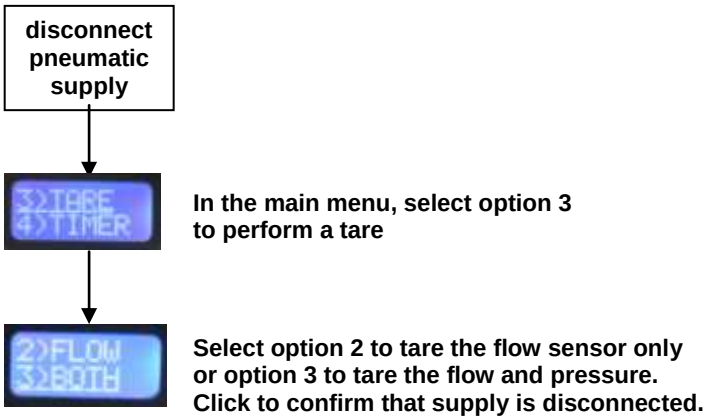


Menu Number	Menu Name	Full Fluid Name
1	H20	Water
2	FC40	FC-40 Fluorinated liquid (as used in Picosurf products)
3	OIL	Light Mineral Oil
4	NOVE	Novec 7500 Hydrofluoroether (as used in Picosurf products)
5	HEXA	Hexadecane

It should be noted that if the flow sensor type is subsequently changed, then the fluid calibration will revert back to water and it will be necessary to re-select if an alternative fluid is required.

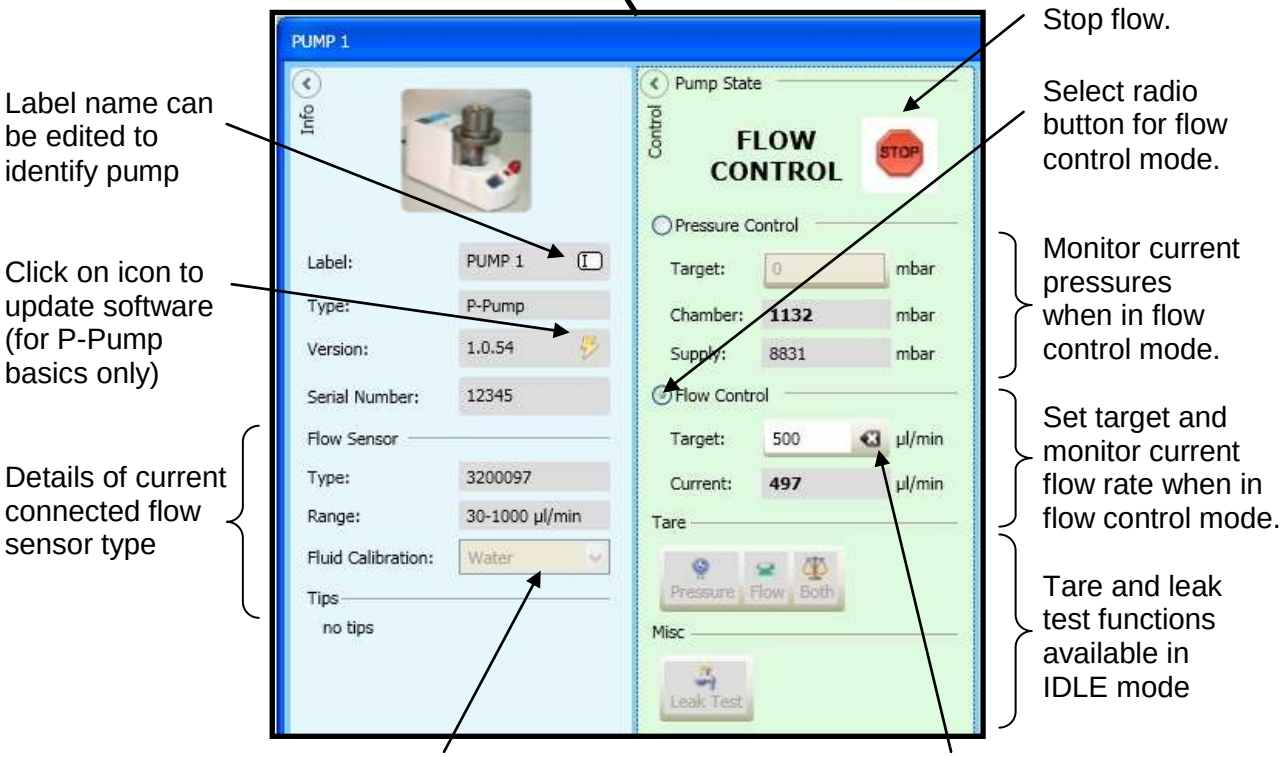
4.5 Taring Flow Rate Sensor

It is recommended to tare the flow rate sensor after the system is set up and connected. If a flow rate sensor tare is performed with little fluidic resistance connected, then the tare may be inaccurate.



5. PC Software User Control

The Mitos Flow Control Centre software enables flow control to be performed from a PC. Mitos P-Pump and Mitos P-Pump Remote pumps connect to your PC via a standard USB cable. Mitos P-Pump Basic and Mitos P-Pump Remote Basic connect to your PC via a serial (RS232) cable or USB to RS232 adapter cable. More information on detecting hardware is available in the Mitos P-Pump Range User Manual.



6. General Notes on Use

6.1 System Stability

The first rule for setting up a system is that it should be stable in pressure control mode for it to be stable in flow control mode. Therefore, the correct flow resistors should be selected to provide the desired flow rate range and stability for 2 phase systems with fluids of different viscosities.

An unstable system means that the flow rate is oscillating around the target value, but is unable to reach stability. The indicator is shown on the left.

Why is my system unstable?

- The flow rate selected requires a very low P-Pump pressure (e.g. < 20 mb) in order to reach the target. The solution is to insert additional flow resistance into the system to increase the pressure required to reach the flow rate target.
- The flow rate selected requires a higher P-Pump pressure than supply pressure in order to reach the target. In this case, the current flow rate displayed will always be lower than target. The solution is to reduce the flow resistance in the system to reduce the pressure required to reach the flow rate target.
- The system is inherently unstable. It is always possible to set up unstable systems when using 2 or more fluids of different viscosities or high flow rate ratios. In general, for 2 phase systems, the flow resistance before the junction should be significantly greater than the flow resistance after the junction.

6.2 Correction Factors for Alternative Fluids

The Mitos Flow Rate Sensors are calibrated for water and 4 common fluids. In order to obtain accurate flow rates for alternative fluids, it is necessary to use correction factors to convert the displayed value into the actual value. A method of providing a known flow rate is required to work out the correction factor for the selected fluid. This could be a syringe pump or a P-Pump delivering fluid onto a precision balance with volume calculated from known density.

For each flow sensor type, it is necessary to pump the selected fluid through the flow sensor at a minimum of 5 different flow rates in the range and record the displayed value. For example, with the 1 – 50 µl/min sensor, displayed readings could be recorded at flow rates of 5, 15, 25, 35 and 45 µl/min. This data can be plotted as a curve of actual flow rate against displayed flow rate. Alternatively, the correction factor can be calculated by dividing actual flow rate by displayed flow rate. The correction factor can then be plotted against displayed flow rate and used to adjust the flow rate values for this selected fluid.

Appendix A. Updating the Software

Flow control is ready to use on all new P-Pumps and Sensor Units and no software update is required. P-Pumps and Sensor Units purchased before 1st July 2012 will need to be updated to the latest version of software. Only P-Pumps with a serial number greater than 160290 can be upgraded. Please contact us for any enquiry regarding updating the software.

Updating P-Pump Basic

The P-Pump Basic can be updated using the update icon in the PC software (see section 6) and browsing to the update file provided by Dolomite.

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